LAKE CATAOUATCHE TMDLS FOR DISSOLVED OXYGEN AND NUTRIENTS

FINAL
April 22, 2005

LAKE CATAOUATCHE TMDLS FOR DISSOLVED OXYGEN AND NUTRIENTS

SUBSEGMENT 020303

Prepared for

US EPA Region 6
Water Quality Protection Division
Permits, Oversight, and TMDL Team

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources (NPS) discharging to the waterbody. This report presents TMDLs that have been developed for dissolved oxygen (DO) and nutrients for Lake Cataouatche (subsegment 020303) in the Barataria basin in southern Louisiana.

Lake Cataouatche is located southwest of New Orleans, LA in the Barataria basin. The drainage area of the subsegment is approximately 69 mi^2. The predominant land uses are water (Lake Cataouatche), wetland forest, and freshwater marsh.

Subsegment 020303 was listed on the Modified Court Ordered 303(d) List for Louisiana as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #3 for TMDL development. The causes for impairment cited in the 303(d) List included organic enrichment/low DO and nutrients. The water quality standard for DO in this subsegment is 5 mg/L year round.

A water quality model (QUAL-TX) was set up to simulate DO, carbonaceous biochemical oxygen demand (CBOD), nutrients, and algae in the subsegment. The model was set up and calibrated using intensive survey data collected for this subsegment in August 2002. Model verification was then performed by using the calibrated model to simulate conditions during a different time period (July 2003) without adjusting model calibration parameters. The model predictions for the verification were similar to the observed data from the July 2003 survey, especially considering that the two surveys were nearly a year apart. Then, in order to develop the most accurate and robust model using all available data, the calibration was adjusted slightly to develop a single set of calibration parameter values that yielded the best match between predicted and observed data for both data sets. The projection simulation was run at critical flows and temperatures to address seasonality as required by the Clean Water Act. In general, the modeling in this study was consistent with guidance in the Louisiana TMDL Technical Procedures Manual.

TMDLs for oxygen demanding substances and nutrients (CBOD, ammonia nitrogen, organic nitrogen, nitrate nitrogen, and phosphorus) were calculated using the results of the projection simulation. In addition to the implicit margin of safety (MOS) that was established through conservative assumptions in the modeling, an explicit MOS of 10% and a future growth allowance of 10% were both included in the TMDL calculations. The results of the modeling and TMDL calculations showed that NPS loads will need to be reduced by approximately 60% for Bayou Verret to meet the DO standard of 5 mg/L; however, no reductions will be needed for Lake Cataouatche to meet the DO standard of 5 mg/L. Oxygen demand from point sources in this subsegment was very small; therefore, the modeling assumed no changes to existing permit limits for point source discharges. The results of the TMDL calculations are summarized in Table ES.1.

Table ES.1. DO and nutrient TMDLs for subsegment 020303 (Lake Cataouatche).

	Loads (kg/day)				
	CBODu	**Organic N**	**Ammonia N**	**NO2+NO3 N**	**Phosphorus**
Point source wasteload allocation (WLA)	231.62	20.45	39.75	99.18	49.59
Nonpoint source load allocation (LA)	17031.30	1068.58	287.50	0.02	0.17
Explicit Margin of Safety (10%)	2157.86	136.13	40.91	12.41	6.22
Future Growth (10%)	2157.86	136.13	40.91	12.41	6.22
Total maximum daily load (TMDL)	21578.64	1361.29	409.07	124.02	62.20

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. Based on EPA’s present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the Mississippi River’s course therefore preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state’s coastal wetlands have undergone and continue to undergo a severe deprivation of sediments and nutrients that has led quite literally to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. It should be pointed out that restoration of these eroding wetlands involves supplying nutrients to these wetlands through managed Mississippi River diversions.

The TMDLs for DO and nutrients in Table ES.1 are based on a critical low flow scenario with 0.1 cfs of flow from the Davis Pond Freshwater Diversion. This scenario resulted in no required load reductions to maintain 5 mg/L of DO in Lake Cataouatche. However, as proposed under the Louisiana Coastal Area Ecosystem Restoration Study (LCA Study), the flow from the Davis Pond Freshwater Diversion could exceed 1,000 cfs. Therefore, additional simulations were performed with higher flows from the Davis Pond Freshwater Diversion. The increased flow from the Davis Pond Freshwater Diversion caused the predicted DO in Lake Cataouatche to increase slightly, so those simulations also resulted in no required load reductions to maintain 5 mg/L of DO in Lake Cataouatche. Based on these results, EPA believes that increased flows from the Davis Pond Freshwater Diversion will enhance DO and decrease the likelihood of nutrient impairment in Lake Cataouatche. Therefore, as the flow from the Davis Pond Freshwater Diversion increases, the nonpoint source LA and the TMDL should increase accordingly. Table ES.2 shows an example of how the nonpoint source LA and the TMDL would increase with a flow of 1,000 cfs from the Davis Pond Freshwater Diversion.

Table ES.2 DO and nutrient TMDLs for subsegment 020303 with 1,000 cfs from Davis Pond Diversion.

	Loads (kg/day)				
	CBODu	**Organic N**	**Ammonia N**	**NO2+NO3 N**	**Phosphorus**
Point source wasteload allocation (WLA)	231.62	20.45	39.75	99.18	49.59
Nonpoint source load allocation (LA)	24918.22	3397.48	718.06	97.88	391.58
Explicit Margin of Safety (10%)	3143.73	427.24	94.73	24.63	55.15
Future Growth (10%)	3143.73	427.24	94.73	24.63	55.15
Total maximum daily load (TMDL)	31437.30	4272.41	947.27	246.32	551.47

Based on EPA's understanding, if any future diversion from the Mississippi River or other tributaries into Lake Cataouatche increases flow, the nonpoint source LA and the TMDL will also be increased proportionately. Based on EPA's current understanding, the diversion projects are supported by both State and Federal agencies, including EPA and the U.S. Army Corps of Engineers. The diversions are managed by the Corps of Engineers and the State, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

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1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for dissolved oxygen (DO) and nutrients for subsegment 020303 (Lake Cataouatche and tributaries). This subsegment was listed on the Modified Court Ordered 303(d) List for Louisiana (EPA 2000) as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #3 for TMDL development. The suspected sources and suspected causes for impairment in the 303(d) List are included in Table 1.1. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7. The 303(d) Listings for other pollutants in this subsegment are being addressed by EPA and the Louisiana Department of Environmental Quality (LDEQ) in other documents.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern, and the LA is the load allocated to nonpoint sources (NPS). The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions, data inadequacies, and future growth.

Table 1.1. Summary of 303(d) Listing of subsegment 020303 (EPA 2000).

Subsegment Number	Waterbody Description	Suspected Sources	Suspected Causes	Priority Ranking (1 = highest)
020303	Lake Cataouatche and tributaries	Industrial Municipal Storm sewers Petroleum activities Spills	Nutrients Organic enrichment/low DO Pathogen indicators Oil & Grease	3

2.0 STUDY AREA DESCRIPTION

2.1 General Information

Lake Cataouatche (subsegment 020303) is located about 13 mi (21 km) southwest of New Orleans, LA in the Barataria basin (see Figure 2.1). Subsegment 020303 extends from the levee on the south side of the Mississippi River to the southern edge of Lake Cataouatche. This subsegment has an area of approximately 69 mi^2 (178 km^2). The main bayou of interest in this subsegment is Bayou Verret, which flows into the north side of Lake Cataouatche. A map of land use is shown in Figure 2.2. As shown in Table 2.1, the primary land uses in the Lake Cataouatche subsegment are water, wetland forest, and freshwater marsh.

One important source of water in this subsegment is the Davis Pond Freshwater Diversion Project. This project diverts water from the Mississippi River east of Luling into a 9,200 acre “ponding area” (marsh) between Highway 90 and Lake Cataouatche. The water disperses through the marsh before entering Lake Cataouatche as distributed inflow along the northwest side of the lake. Berms built on the east and west sides of the ponding area cause this water to flow into Lake Cataouatche rather than adjacent bayous and canals. Davis Pond was designed to re-introduce freshwater, sediments, and nutrients into the marshes and bays of the Barataria basin. The objectives of the project are to enhance emergent marsh vegetation growth, reduce marsh loss, and increase the productivity of significant commercial and recreational fisheries and wildlife. The project was constructed between 1997 and 2002 and began operations in July 2002 (LDNR 2002).

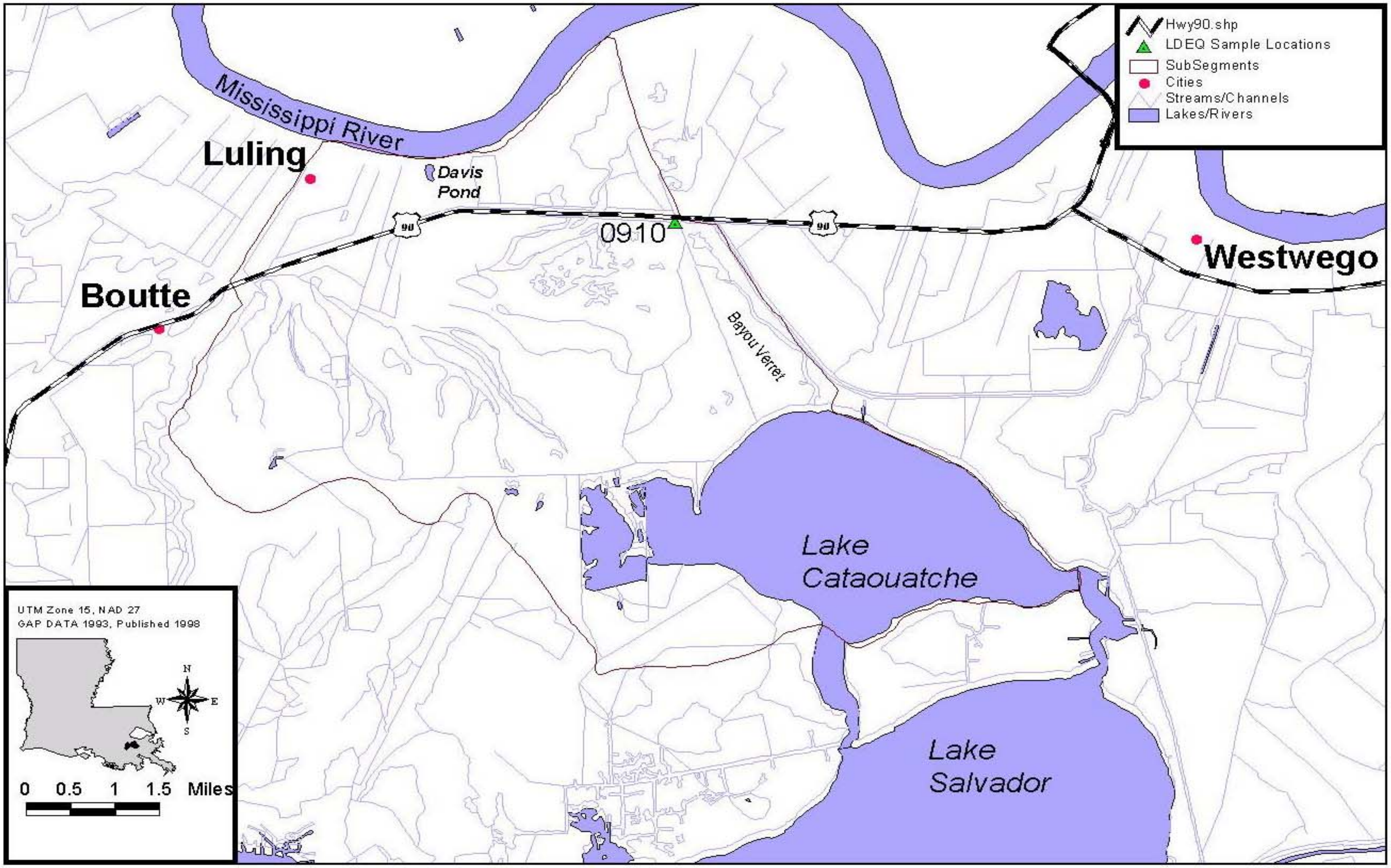

Figure 2.1. Watershed map for subsegment 020303.

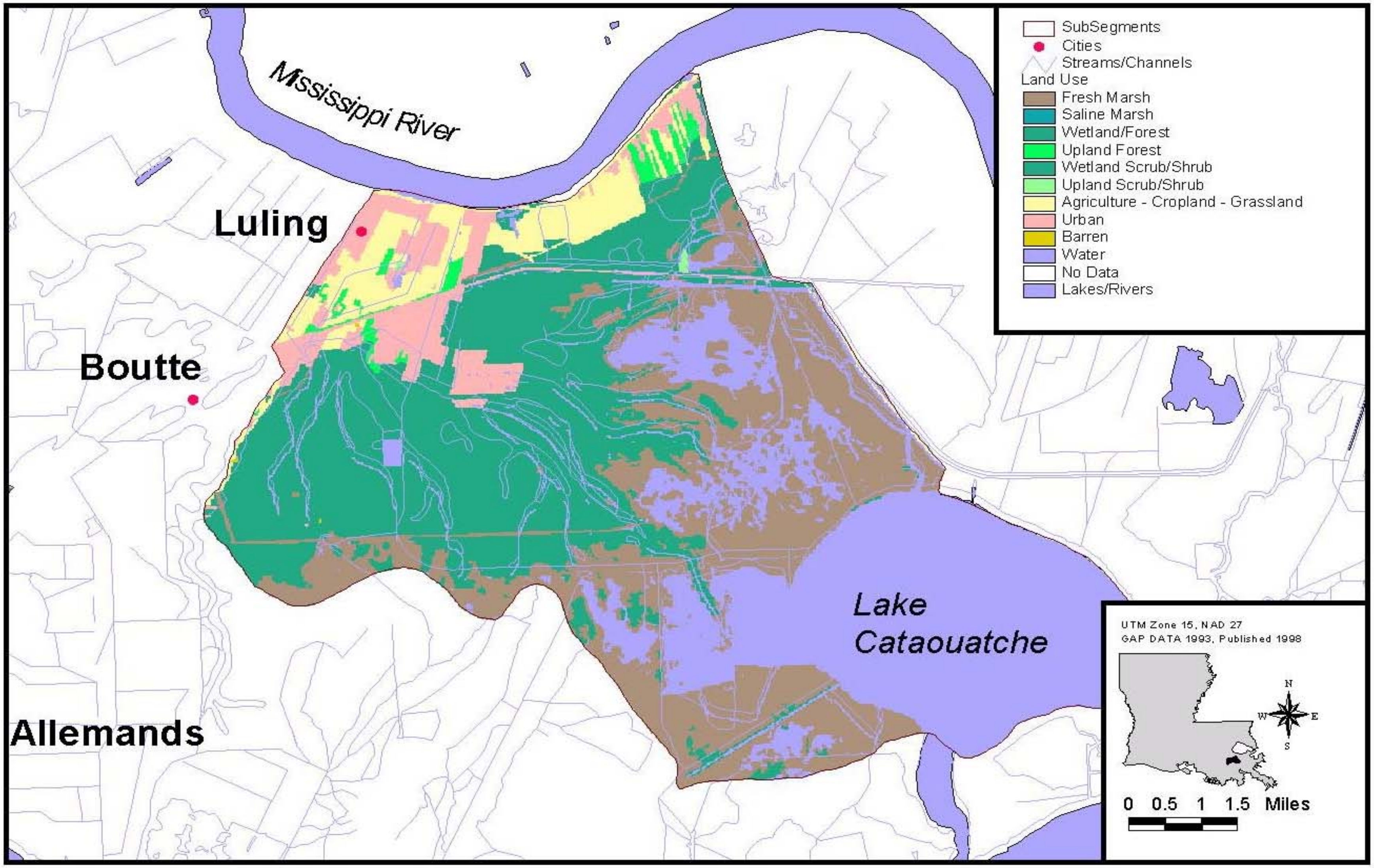

Figure 2.2. Land use for Lake Cataouatche (020303).

Table 2.1. Land uses in subsegment 020303 based on GAP data (USGS 1998).

Land Use Type	% of Total Area
Freshwater Marsh	24.4%
Saline Marsh	0.0%
Wetland Forest	30.1%
Upland Forest	1.0%
Wetland Scrub/Shrub	1.1%
Upland Scrub/Shrub	0.0%
Agricultural	5.5%
Urban	5.5%
Water	32.4%
Barren Land	0.0%
TOTAL	100.0%

2.2 Water Quality Standards

The numeric water quality standards and designated uses for this subsegment are shown in Table 2.2. The primary numeric standard for the TMDLs presented in this report is the DO standard of 5 mg/L year round.

Table 2.2. Water quality standards and designated uses (LDEQ 2003a).

Subsegment Number	020303
Waterbody Description	Lake Cataouatche and Tributaries
Designated Uses	ABC
Criteria:	
Chloride	500 mg/L
Sulfate	150 mg/L
DO	5 mg/L (year round)
pH	6.0-8.5
Temperature	32 °C
TDS	1000 mg/L

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

Louisiana does not have numeric water quality standards for nutrients, but Louisiana's narrative standard for nutrients states that:

- The naturally occurring range of nitrogen-phosphorus ratios shall be maintained (except for intermittent streams), and
- Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters.

The Louisiana water quality standards also include an antidegradation policy (LAC 33: IX.1109.A). This policy states that state waters exhibiting high water quality should be maintained at that high level of water quality. If this is not possible, water quality of a level that supports the designated uses of the waterbody should be maintained. Changing the designated uses of a waterbody to allow a lower level of water quality can only be achieved through a use attainability study.

2.3 Point Sources

A listing of NPDES permits in the Barataria and Terrebonne basins of Louisiana was prepared by EPA Region 6 using databases and permit files from LDEQ. This list was used to identify any permitted discharges within subsegment 020303. Based on this listing, five NPDES permitted discharges were identified within subsegment 020303 and are shown in Appendix A.

2.4 Nonpoint Sources

The only suspected nonpoint source specifically identified for subsegment 020303 in the February 29, 2000 Modified Court Ordered 303(d) List for Louisiana (EPA 2000) was storm sewers. Based on LDEQ's experience in the Barataria basin, it is suspected that there is considerable nonpoint oxygen demand in this subsegment that is natural (i.e., not induced by human activities).

2.5 Historical Data

The only historical water quality data that were found for this subsegment were the data for LDEQ station 0910, which is located near the Highway 90 bridge over Bayou Verret (see Figure 2.1). These data are shown in Table 2.3 below. This station had only one year of monthly values; three of the 12 DO measurements were below the water quality standard of 5 mg/L.

2.6 Previous Studies

The only report that was found for background information was an annual report for the Davis Pond Freshwater Diversion Project (LDNR 2002). No previous water quality studies were found for this subsegment.

Table 2.3. DO data for LDEQ station 0910 (near Highway 90 bridge over Bayou Verret).

Date	Time	DO (mg/L)	Meets standard?
1/11/00	9:42	8.43	Yes
2/8/00	10:08	11.17	Yes
3/14/00	11:20	10.89	Yes
4/11/00	9:55	6.53	Yes
5/9/00	10:15	8.34	Yes
6/13/00	9:45	4.31	No
7/11/00	9:50	2.17	No
8/8/00	10:16	5.41	Yes
9/12/00	10:00	4.07	No
10/3/00	8:31	6.87	Yes
10/31/00	9:15	8.92	Yes
12/5/00	9:35	7.52	Yes

3.0 FIELD SURVEYS

Two surveys were conducted on subsegment 020303 by FTN personnel to obtain data needed for the model. Table 3.1 below gives a list of the sites and the data collected at them. Figure 3.1 shows the locations of the sampling sites. Detailed documentation of data from these surveys is available in previously submitted reports (FTN 2002, FTN 2003). Both surveys were conducted about a week after significant rainfall occurred.

The calibration survey was performed during August 19 through 23, 2002. Water quality data were gathered from a total of eight sites on August 21. Continuous monitors were set up at two sampling sites and recorded measurements from August 19 to August 23. A dye study was performed and several stream cross-sections were taken. Data from this survey are summarized in Appendix B.

A second survey, the verification survey, was performed on July 8-12, 2003. The same sampling sites were used but no cross sections were measured. Data from this survey are summarized in Appendix C.

The 20-day CBOD time series data for each sample were input to a LDEQ spreadsheet called GSBOD to calculate an ultimate CBOD (CBODu) and CBOD decay rate for each sample. For most stations, the calculated CBODu values were higher for the calibration survey than for the verification survey. The average CBODu decay rate was 0.25/day for the calibration survey and 0.30/day for the verification survey.

The continuous monitoring data from both surveys showed greater diurnal DO variation in Bayou Verret (station 020303-1) than in Lake Cataouatche (station 020303-14 and 020303-7). This indicated higher algae productivity in Bayou Verret.

The dye studies from both surveys showed diurnal flow reversals in Bayou Verret.

Table 3.1. Summary of calibration and verification surveys.

Station Name	Data That Were Collected				
	In Situ	**WQ Samples**	**Dye Study**	**Cross Section**	**Continuous Monitor**
020303-0	C				
020303-1	C,V	C,V			C,V
020303-2	C,V		V		
020303-3	C,V	C,V			
020303-4	C,V				
020303-5	C,V				
020303-6	C,V				
020303-7	C,V	C,V			V
020303-8	C,V				
020303-9	C,V	C,V			
020303-10	C,V	C,V			
020303-11	C,V				
020303-12	C,V	C,V			
020303-13	C,V				
020303-14	C,V	C,V			C
020303-15	V				
T1				C	
T2			C	C	
T3				C	

C – Calibration survey (8/21/02)
V – Verification survey (7/9/03)

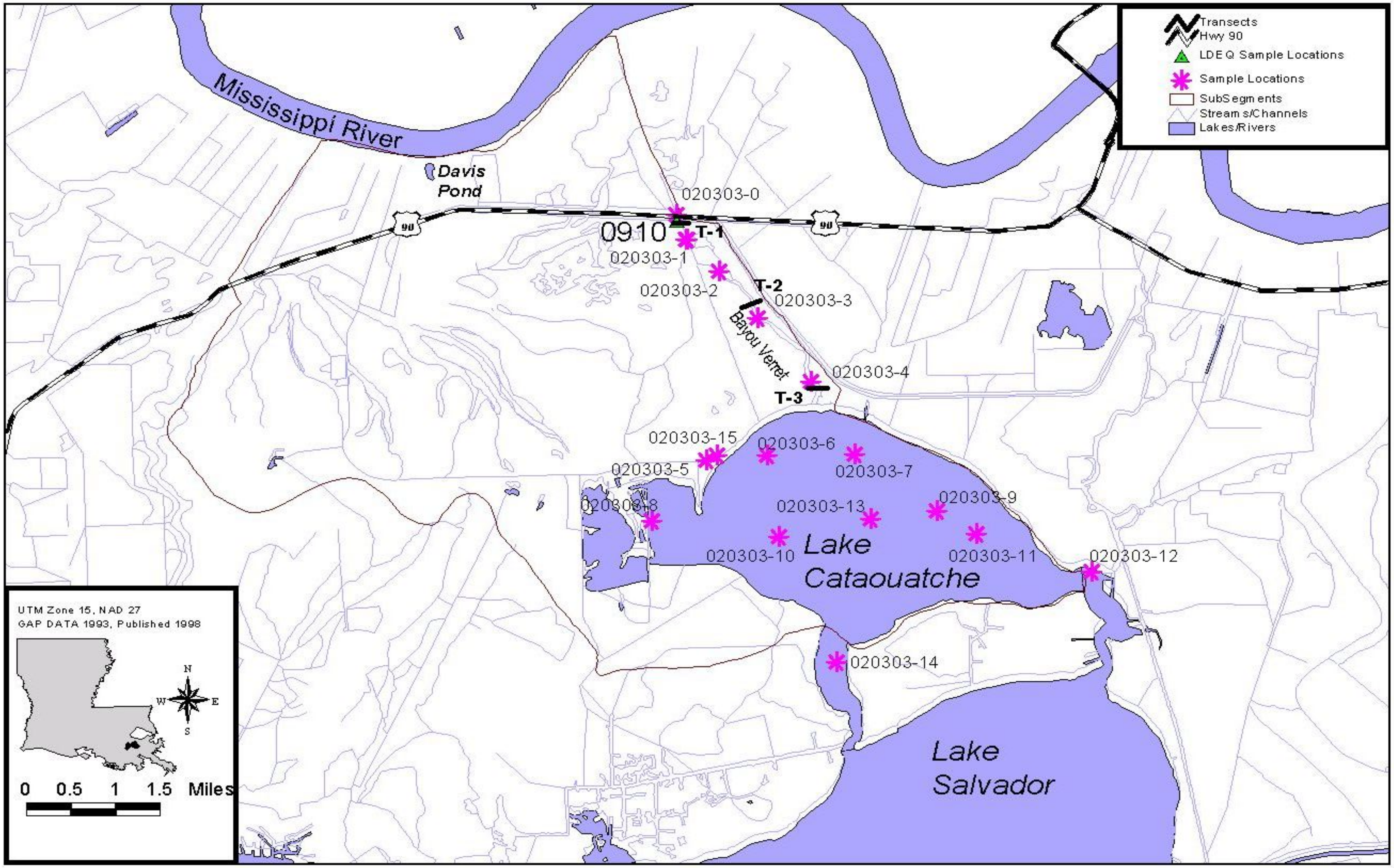

Figure 3.1. Sampling locations for subsegment 020303.

4.0 CALIBRATION OF WATER QUALITY MODEL

4.1 Model Setup

In order to evaluate the linkage between pollutant sources and water quality, a computer simulation model was used. The model used for this TMDL was QUAL-TX (version 3.3), which was selected because it includes the relevant physical, chemical, and biological processes and it has been used successfully in the past for other TMDLs in Louisiana. The QUAL-TX model was set up to simulate organic nitrogen, ammonia nitrogen, nitrate nitrogen, ortho phosphorus, algae, ultimate carbonaceous biochemical oxygen demand (CBODu), and DO. The data used to calibrate the model were taken from the calibration survey performed on August 19-22, 2002 (see Section 3.0).

The model was set up with 7 reaches. The main stem of Bayou Verret was divided into 3 reaches to represent varying depths and widths along the stream. All of the reaches were divided into smaller elements to simulate any variations in water quality within each reach. Lake Cataouatche was divided into 4 reaches based on depths measured during the field survey. The reaches were assumed to contain uniform water quality and therefore were not divided into smaller elements.

4.2 Temperature Correction of Kinetics (Data Type 4)

The temperature correction factors used in the model were consistent with the Louisiana Technical Procedures Manual (the "LTP"; LDEQ 2003b). These correction factors were:

• Correction for BOD decay:	1.047 (value in LTP is same as model default)
• Correction for SOD:	1.065 (specified in Data Group 4)
• Correction for ammonia N decay:	1.070 (specified in Data Group 4)
• Correction for organic N decay:	1.020 (not specified in LTP; model default used)
• Correction for reaeration:	automatically calculated by the model

4.3 Hydraulics (Data Types 9 and 10)

The hydraulics for each reach were specified in the input for the QUAL-TX model using the power functions (velocity = a * Q^b and depth = c * Q^d + e). Because water levels in Bayou

Verret and Lake Cataouatche are controlled by tides and wind (rather than flow), it was assumed that the width and depth of each reach were independent of flow. Therefore, the exponents ("b" and "d") were set equal to one and zero, respectively, and the coefficients ("a" and "c") were set equal to the inverse of the reach cross sectional area and the depth respectively. The reach depths were based on measurements from the 2002 FTN intensive survey. The FTN intensive survey included cross section data at three sites in Bayou Verret and depth measurements at six locations in Lake Cataouatche. The depth for each reach in Lake Cataouacthe was determined by averaging the depths measured within that reach. The reach widths within Lake Cataouatche were determined by dividing the surface area of each reach by the reach length. Plots of depth and width versus river kilometer are shown with the calibration output plots in Appendix I.

Because the waterbody is tidally influenced, a dispersion coefficient was included in the model input. Originally, the dispersion coefficient was calculated from the dye study data (2.6 m^2/sec; shown in Appendix D) and used for all reaches. However, the dispersion coefficient was reduced to 0.5 m^2/sec in the bayou reaches to calibrate specific conductivity. The model inputs for the calibration are summarized in Appendix E.

4.4 Initial Conditions (Data Type 11)

Because temperature and salinity are not being simulated in the model, the temperature and salinity for each reach were specified in the initial conditions based on in-situ measurements at the station(s) located within each reach. The salinity was calculated from the specific conductivity. The initial conditions for constituents being simulated were set equal to the calibration target values, but those values are only used by the model only as a starting point for the iterative solution technique. The inputs for chlorophyll, nitrate + nitrite, and ortho phosphorus were taken from laboratory analyses of grab samples collected during the calibration survey. The input data and sources are shown in Appendix E.

4.5 Water Quality Kinetics (Data Types 12 and 13)

Kinetic rates used in QUAL-TX include reaeration rates, CBOD decay rates, nitrification rates, mineralization rates (organic nitrogen decay), and benthic source rates for phosphorus and nitrogen. The values used in the model input are shown in Appendix E.

Reaeration rates were manually specified in the model. These rates were calculated by dividing the surface transfer coefficient by the reach depth. For Bayou Verret, a surface transfer coefficient of 0.664 m/day was used which is consistent with the Louisiana Equation. For Lake Cataouatche, a wind-aided surface transfer coefficient was calculated to be 0.82 m/day using wind data from New Orleans International Airport for August 20, 2002. These calculations are shown in Appendix F.

The initial CBOD decay rates were calculated from data collected during the calibration survey using the GSBOD spreadsheet provided by LDEQ. By entering CBOD time series measurements for each sampling station, a CBOD decay rate was determined for each station (shown in Appendix B). Then the rates for all the stations were averaged to determine one final average that was initially used for all reaches in the model (0.25/day). However, the CBOD decay rates were later decreased to 0.05/day in order to achieve an acceptable calibration for DO. The CBOD decay rates calculated from the BOD time series data may have been high because the laboratory “seeded” the samples (which can cause the BOD to decay faster than it would in a natural waterbody).

The nitrification rates in the model were initially set to 0.10/day for all reaches based on values used in water quality models for previous TMDLs in southern Louisiana. During calibration, though, the values for Bayou Verret were reduced to 0.05/day to obtain a better match between predicted and observed data.

The mineralization (organic nitrogen decay) rates in the model were set to 0.01/day for all reaches. This value was similar to the values shown in Table 5.3 of the “Rates, Constants, and Kinetics” publication (EPA 1985) for dissolved organic nitrogen being transformed to ammonia nitrogen. The literature values for mineralization rates are shown in Appendix G.

Finally, benthic source rates for phosphorous and ammonia were entered. These rates were used as tuning knobs to calibrate the nutrients and algae. The values used in the model calibration are shown in Appendix E.

4.6 Algae Coefficients (Data Types 3, 6, and 14)

Because algae was being simulated, several rates and coefficients had to be entered into the model, some of which were used for calibration. Half saturation values for phosphorus, nitrogen, and light were used in the calibration. The solar radiation constant was set to the long term average solar radiation for New Orleans during August (416 langleys; U.S. Department of Commerce 1979) instead of using the QUAL-TX default value of 500. Rates for algal growth, settling, and respiration were also used in the calibration. The algal respiration rate was held constant (i.e. did not vary by reach). Rates for algal growth and settling were varied between the bayou and lake portions of the model. The algae inputs are shown in Appendix E.

4.7 Nonpoint Source Loads (Data Types 12, 13, and 19)

The NPS loads that are specified in the model can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, benthic ammonia and phosphorus source rates, CBODu loads, and organic nitrogen loads. The SOD (specified in data type 12), the benthic ammonia and phosphorus source rates (specified in data type 13), and the mass loads of organic nitrogen and CBODu (specified in data type 19) were all treated as calibration parameters; their values were adjusted to bring the model output closer to the calibration target values.

4.8 Headwater Flow Rate (Data Type 20)

The headwater flow rate was calculated from the calibration survey dye study. The cumulative velocity for the last run (3.7×10^{-5} m/sec) from the dye study was multiplied by the cross sectional area of the transect closest to the dye injection location (Transect 1; 56 m^2) to compute a volumetric headwater flowrate (2.1×10^{-3} m^3/sec).

4.9 Headwater Water Quality (Data Type 21 and 22)

The temperature and water quality concentrations that were specified in the model for the headwater flow were based on data from the FTN calibration survey in August 2002. Average values from samples 020303-1A and 020303-1B (separate samples collected at the same station) were used for headwater water quality. The DO was a 24 hour average from midnight to midnight on August 21, 2002 at samples 020303-1. CBODu was calculated by entering CBOD measurements from stations 020303-1A and 020303-1B into the GSBOD spreadsheet supplied by LDEQ and averaging the resulting CBODu values. Nitrate + nitrite was set to 0.05 mg/L since the nitrate concentrations were below the detection limits of 0.1 mg/L. The organic nitrogen concentration was set to the measured TKN value minus the ammonia concentration. The values used as model inputs are shown in Appendix E.

4.10 Tributary Inputs (Data Types 24 and 25)

Two tributaries were included in the model, Louisiana Cypress Lumber Canal and Davis Pond Freshwater Diversion. The flow for the Lumber Canal was estimated using the depth and stream velocity measured at station 020303-5 and the stream width taken from DOQQs. Water quality data were obtained from the FTN calibration survey on August 21, 2002. Temperature and specific conductivity were measured at station 020303-5. An average daily DO value was estimated using the instantaneous DO reading at station 020303-5 and continuous DO monitoring data at station 020303-1. Other water quality parameters were estimated by averaging the values from samples 020303-1A and 020303-1B (no laboratory data were available for station 020303-5).

For Davis Pond, neither flow data nor water quality data were available. Therefore, flow was estimated by calibrating specific conductivity. Water quality values were assumed to be similar to values for the Lumber Canal.

4.11 Lower Boundary Conditions (Data Type 27)

Because dispersion was being simulated, lower boundary conditions were included in the model. The lower boundary conditions were calculated by averaging water quality data from stations 020303-12 and 020303-14. The values used as model inputs are shown in Appendix E.

4.12 Model Results for Calibration

Plots of predicted and observed water quality for the calibration are presented in Appendix I and a printout of the QUAL-TX output file is included as Appendix J. The calibration was considered to be acceptable based on the amount of data that were available.

5.0 VERIFICATION OF WATER QUALITY MODEL

5.1 Model Setup

After completing the calibration of the water quality model as described in Section 4, the model was verified by simulating conditions during a different time period (the verification survey) without adjusting model calibration parameters. The objective of the model verification was to evaluate how accurately the calibrated model an predict water quality for conditions other than the calibration period. The accuracy of water quality predictions for other conditions is important because the whole reason for using a model is to predict water quality for critical conditions (which are different than calibration conditions).

To achieve this objective, the verification was performed using the calibrated model to simulate conditions from the verification survey without adjusting the calibration parameters. The only model inputs that were changed from the calibration to the verification were the initial conditions for variables not simulated (temperature and salinity) and the external boundary conditions (headwater and tributary flows and quality, downstream boundary conditions, and wind-based reaeration). Each input that was changed is discussed below; all other inputs were the same as in the calibration simulation.

5.2 Initial Conditions (Data Type 11)

Data from the verification survey were used for the initial conditions inputs. The temperature and salinity for each reach were specified in the initial conditions based on in-situ measurements at the station(s) located within each reach. The salinity was calculated from the specific conductivity. The initial conditions for DO and ammonia were set equal to the verification target values, but these values are used by the model only as a starting point for the iterative solution technique. As before, an estimated daily average DO was computed for each station (shown in Appendix K). The inputs for chlorophyll, nitrate-nitrite, and phosphorus were taken from laboratory analyses of grab samples. The verification input data and sources are shown in Appendix L.

5.3 Water Quality Kinetics (Data Types 12 and 13)

Reaeration rates were manually specified in the model. These rates were calculated by dividing the surface transfer coefficient by the reach depth. For Bayou Verret, a surface transfer coefficient of 0.664 m/day was used (the same as in the calibration). For Lake Cataouatche, a wind-aided surface transfer coefficient was calculated to be 0.74 m/day using wind data from New Orleans International Airport for July 9, 2003. These calculations are shown in Appendix M.

5.4 Headwater Flow Rates (Data Type 20)

The inflow was calculated from the verification survey dye study. The velocity for the third run (0.03 m/sec) from the dye study was multiplied by the cross sectional area of the transect closest to the dye injection location (Transect 1, 56 m^2) to compute a volumetric headwater flowrate (1.68 m^3/sec).

5.5 Headwater Water Quality (Data Type 21 and 22)

Headwater temperature and water quality concentrations for the verification run were based on data from the FTN verification survey on July 9, 2003 using station 020303-1. CBODu was calculated using a spreadsheet supplied by LDEQ. By placing CBOD time series (shown in Appendix C) data into the spreadsheet a CBODu was calculated for station 020303-1 which was then used a model input. Nitrate plus nitrite was set to 0.05 mg/L since the nitrate and nitrite concentrations were below the detection limit of 0.1 mg/L. The organic nitrogen concentration was the TKN value minus the ammonia concentration.

5.6 Tributary Inputs (Data Types 24 and 25)

For the Louisiana Cypress Lumber Canal, the flow for the verification model (0.72 m^3/s) was estimated using the flow calculated for the calibration model (0.9 m^3/s) and the ratio of stream velocities measured at station 020303-5 during the calibration (0.15 m/s) and verification (0.12 m/s) surveys. Water quality data were obtained from the FTN verification survey on July 9, 2003. Temperature and specific conductivity were measured at station 020303-5. An average daily DO value was estimated using the DO reading at station 020303-5 and continuous DO monitoring data at station 020303-1. Other water quality parameters were estimated using data from station 020303-1.

For the Davis Pond Freshwater Diversion, no flow or velocity data were available. Therefore, the flow for the verification model (8.0 m^3/s) was estimated using the flow from the calibration model (10.0 m^3/s) and the ratio of the verification and calibration velocities for the Lumber Canal (0.12 and 0.15 m/s, respectively). Temperature and specific conductivity were measured at station 020303-15. An average daily DO value was estimated using the DO reading at station 020303-15 and continuous DO monitoring data at station 020303-1. Other water quality parameters were estimated using data from station 020303-1.

5.7 Lower Boundary Conditions (Data Type 27)

The lower boundary conditions for the verification run were calculated by averaging water quality data from stations 020303-12 and 020303-14. Average daily DO values for stations 020303-12 and 020303-14 were estimated using the respective DO readings at these stations and the continuous monitoring data at station 020303-7.

5.8 Model Results for Verification

Plots of predicted and observed water quality for the verification are presented in Appendix N and printout of the QUAL-TX output file is included as Appendix O. The verification was considered to be good based on the fact that the calibration survey and the verification survey were conducted almost a year apart and two major storms (Tropical Storm Isidore and Hurricane Lilly) moved through the Barataria basin during the time between the two surveys. Storms like these that bring large amounts of rain and wind are known to have significant effects on water quality due to resuspension of bottom deposits and flusing of dissolved and particulate organic materials from marshes into bayous and lakes. Prior to performing this verification, it was anticipated that the model would poorly predict water quality for the verification due to possible changes in the benthic characteristics of the waterbody during the time between the surveys. Although the model predictions for the verification did not quite match the observed data as closely as the calibration, the results were considered good for a "blind" verification (applying the calibrated model to a new data set without adjusting calibration parameters).

6.0 REVISED CALIBRATION OF WATER QUALITY MODEL

As discussed in Section 3.0, two surveys were conducted for this project. The model was calibrated to the calibration survey data (Section 4.0) and then run with boundary conditions from the verification survey as inputs (Section 5.0). Then, in order to develop the most accurate and robust model using all available data, the calibration was adjusted slightly to develop a single set of calibration parameter values that yielded the best match between predicted and observed data for both data sets. The adjustments to the calibration are discussed below and the revised calibration parameters are listed in Table 6.1.

First, the CBODu mass loads were decreased since the model overpredicted the observed CBODu concentrations from the verification survey. Next the ammonia source rates were increased in several reaches to adjust the predicted ammonia concentrations. This increased the algae concentrations, especially in the lake itself. The decrease in CBODu mass loads and the increase in algae concentrations lead to an increase in DO. To compensate, the SOD were increased in several reaches to lower the DO.

The plots of the adjusted calibration and verification can be seen in Appendix P and Appendix Q, respectively. A printout of the adjusted calibration and verification output files can be found in Appendix R and Appendix S, respectively.

Table 6.1. Adjustments to model calibration parameters.

Parameter	Reach(es)	Original Value	Adjusted Value
Sediment oxygen demand, $g/m^2/day$	2	1.6	1.8
	3	1.3	1.8
	4	0.5	0.3
Benthic ammonia nitrogen, $g/m^2/day$	2	0.0025	0.0035
	3	0.0020	0.0025
	4	0.0020	0.0100
	5	0.0020	0.0100
	6	0.0020	0.0125
	7	0.0020	0.0075
Algae growth rate, day^{-1}	4 – 7	1.05	0.80
CBODu mass loads, kg/day	1	68	60
	2	98	165
	3	120	90
	4	2600	2000
	5	5000	3000
	6	16600	13280
	7	3600	2880

7.0 WATER QUALITY MODEL PROJECTION

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Therefore, the calibrated model was used to project water quality for critical conditions. The identification of critical conditions and the model input data used for critical conditions are discussed below.

7.1 Identification of Critical Conditions

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the consideration of seasonal variation of conditions affecting the constituent of concern and the inclusion of a MOS in the development of a TMDL. For the TMDL in this report, analyses of LDEQ long-term ambient data were used to determine critical seasonal conditions. A combination of implicit and explicit MOS was used in developing the projection model.

Critical conditions for DO have been determined for Louisiana waterbodies in previous TMDL studies. The analyses concluded that the critical conditions for DO concentrations occur during periods with negligible nonpoint runoff, low stream flow, and high water temperature.

When the rainfall runoff (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the stream temperature is lowered by the cooler precipitation and runoff. In addition, runoff coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. DO saturation values are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and DO but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the waterbody, which is, in turn, expressed as SOD and/or resuspended BOD in the model. This accumulated loading has its greatest impact on the waterbody during periods of higher temperature and lower flow.

According to the LTP, critical summer conditions in DO TMDL projection modeling are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is higher, for all headwaters, and 90th percentile temperature for the summer season. Model loading is from perennial tributaries, SOD, and resuspension of sediments.

In reality, the highest temperatures occur in July-August and the lowest stream flows may occur in other months. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implicit MOS that is not quantified. Over and above this implicit MOS, 20% of the allowable loading was set aside for an explicit MOS and for future growth for the TMDLs in this report. Both the implicit MOS and the explicit MOS account for model uncertainty.

7.2 Temperature Inputs

The LTP (LDEQ 2003) specified that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled. Because the LDEQ monitoring station in this subsegment (station 0910) had only one year of data, LDEQ data for another subsegment were used for this analysis. Long term temperature data from Bayou Segnette near Westwego, Louisiana (LDEQ station 0296) were used to calculate a 90th percentile summer temperature of 30.9EC, which was adjusted to 31.2EC based on short term differences in water temperature between stations 0910 and 0296. This was used as the temperature for all reaches and boundary conditions in the model. The model inputs for the projection are shown in Appendix T. The 90th percentile temperature calculations are shown in Appendix U.

Because Lake Cataouatche has a year round standard for DO, a winter projection simulation was not performed. As discussed above, the most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows (i.e., summer).

7.3 Headwater Inputs

The inputs for the headwaters for the projection simulation were based on guidance in the LTP. The DO concentration for the headwater inflows was set to the more critical of 90% saturation at the critical temperature or the estimated daily average DO based on continuous monitoring data from the calibration and verification surveys. Headwater concentrations for other parameters were kept at the calibration values.

A published 7Q10 flow for Bayou Verret does not exist. Given the low flow observed during the calibration survey, it was assumed that the 7Q10 flow for Bayou Verret was less than 0.1 cfs. The LTP specifies that the critical flow rate for summer should be set to the 7Q10 flow or 0.1 cfs, whichever is higher. Therefore, the headwater flow rate in the projection simulation was set to 0.1 cfs.

7.4 Tributary Inputs

For Louisiana Cypress Lumber Canal, a published 7Q10 flow does not exist; therefore, the flow rate for the Lumber Canal was set to 0.l cfs per the LTP.

For the Davis Pond Freshwater Diversion, a planned minimum discharge of 1000 cfs from the Davis Pond diversion structure was documented (LDNR 2002); however, given the large size of the ponding area, it is unknown how much of this flow would actually enter Lake Cataouatche. Test simulations with varying flows for Davis Pond showed that lower flows produced lower minimum DO values. Therefore, the flow rate for Davis Pond was set to 0.1 cfs per the LTP.

7.5 Nonpoint Source Loads

The initial projection simulation showed DO values in Bayou Verret below the water quality standard of 5.0 mg/L while the DO values in Lake Cataouatche were above the standard. Therefore, the NPS loadings in Bayou Verret were reduced until all of the predicted DO values were equal to or greater than the water quality standard. The same percent reduction was applied to all components of the NPS loads (SOD, benthic ammonia and phosphorus source rates, and mass loads of CBODu and ammonia nitrogen). No reductions in NPS loads were made in Lake Cataouatche. The values used as model input in the projection simulation are shown in Appendix T.

7.6 Reaeration

For the projection, the surface transfer coefficient for reaeration (K_L) was calculated based on long term average wind speeds rather than the wind speed during the intensive survey. Long term average wind speeds for each month of the year for New Orleans were examined and the lowest value within the summer season (May through October) was used to calculate the K_L value. These calculations are shown in Appendix V.

7.7 Other Inputs

The only model inputs that were changed from the calibration to the projection simulation were the inputs discussed above in Sections 7.2 through 7.6. Other model inputs (e.g., hydraulic and dispersion coefficients, decay rates, reaeration equations, etc.) were unchanged from the calibration simulation.

7.8 Model Results for Projection

A plot of predicted DO for the projection is presented in Appendix W and a printout of the QUAL-TX output file is included as Appendix X.

A NPS load reduction of approximately 60% was required to bring the predicted DO values in Bayou Verret to at least 5.0 mg/L. This percentage reduction for NPS loads represents a percentage of the entire NPS loading, not a percentage of the manmade NPS loading. The NPS loads in this report were not divided between natural and manmade because it would be difficult to estimate natural NPS loads for the study area. There are no LDEQ reference streams in the Barataria basin.

Oxygen demand from point sources in this subsegment was very small; therefore, the modeling assumed no changes to existing permit limits for point source discharges.

8.0 TMDL CALCULATIONS

8.1 DO and Nutrient TMDLs

TMDLs for DO and nutrients were calculated for the Lake Cataouatche subsegment based on the results of the projection simulation. In addition to the simulated loads in the model, the TMDLs also include loads for 3 oxygen-demanding point source discharges within this subsegment. The TMDLs are presented as allowable loads of CBODu, organic nitrogen, ammonia nitrogen, nitrite+nitrate nitrogen, and phosphorus. The TMDL calculations were performed using an Excel spreadsheet developed by FTN personnel (shown in Appendix Y). A summary of the loads is presented in Table 8.1.

Table 8.1. DO and nutrient TMDLs for subsegment 020303 (Lake Cataouatche).

	Loads (kg/day)				
	CBODu	**Organic N**	**Ammonia N**	**NO2+NO3 N**	**Phosphorus**
Point source wasteload allocation (WLA)	231.62	20.45	39.75	99.18	49.59
Nonpoint source load allocation (LA)	17031.30	1068.58	287.50	0.02	0.17
Explicit Margin of Safety (10%)	2157.86	136.13	40.91	12.41	6.22
Future Growth (10%)	2157.86	136.13	40.91	12.41	6.22
Total maximum daily load (TMDL)	21578.64	1361.29	409.07	124.02	62.20

8.2 Recommendations for NPS and Point Source Loads

In summary, the projection modeling used to develop the TMDLs above showed that NPS loads need to be reduced by 60% for Bayou Verret to maintain the DO standard of 5 mg/L; however no reduction will be needed for Lake Cataouatche to meet the DO standard of 5 mg/L.

Because oxygen demand from point sources in this subsegment was very small, the modeling assumed no changes to existing permit limits for point source discharges. The nonconservative behavior of dissolved oxygen allows many small to remote point source dischargers to be assimilated by their receiving waterbodies before they reach the modeled waterbody. These dischargers are said to have very little to no impact on the modeled waterbody and therefore, they are not included in the model and are not subject to any reductions based on this TMDL. These facilities are permitted in accordance with state regulation and policies that provide adequate protective controls. New similarly insignificant point sources will continue to be issued permits in this manner. Significant existing point source dischargers are either included in the TMDL model or are determined to be insignificant by other modeling. New significant point source dischargers would have to be evaluated individually to determine what impact they have on the impaired waterbody and the appropriate controls.

Although the nutrient TMDL includes a WLA for phosphorus, it is recommended that as a first step to implement this TMDL, the point sources should be given monitoring requirements in their permits to determine if phosphorus effluent limitations are appropriate.

8.3 Increased Inflows From Diversions

Much of coastal Louisiana was built by the process of delta formation through flooding and deposition of sediments by the rise and fall of the Mississippi River. Based on EPA's present knowledge, extensive areas of wetlands and coastal marshes are affected by a high rate of subsidence and degradation, primarily due to a lack of historical sediment and nutrients entering the wetlands. Subsidence is a natural process, but the building of levee systems has restricted the Mississippi River's course therefore preventing the natural cycle of the river and the natural process of delta formation. According to EPA, a large portion of the state's coastal wetlands have undergone and continue to undergo a severe deprivation of sediments and nutrients that has led quite literally to the breakup of the natural system. In addition, EPA believes that many of Louisiana's wetlands have become isolated from the riverine sources that created them and are becoming stagnant and starved for nutrients and organic and inorganic sediments. It should be pointed out that restoration of these eroding wetlands involves supplying nutrients to these wetlands through managed Mississippi River diversions.

The TMDLs for DO and nutrients in Table 8.1 are based on a critical low flow scenario with 0.1 cfs of flow from the Davis Pond Freshwater Diversion. This scenario resulted in no required load reductions to maintain 5 mg/L of DO in Lake Cataouatche. However, as proposed under the Louisiana Coastal Area Ecosystem Restoration Study (LCA Study), the flow from the Davis Pond Freshwater Diversion could exceed 1,000 cfs. Therefore, additional simulations were performed with higher flows from the Davis Pond Freshwater Diversion. The increased flow from the Davis Pond Freshwater Diversion caused the predicted DO in Lake Cataouatche to increase slightly, so those simulations also resulted in no required load reductions to maintain 5 mg/L of DO in Lake Cataouatche. Based on these results, EPA believes that increased flows from the Davis Pond Freshwater Diversion will enhance DO and decrease the likelihood of nutrient impairment in Lake Cataouatche. Therefore, as the flow from the Davis Pond Freshwater Diversion increases, the nonpoint source LA and the TMDL should increase accordingly. Table 8.2 shows an example of how the nonpoint source LA and the TMDL would increase with a flow of 1,000 cfs from the Davis Pond Freshwater Diversion.

Table 8.2. DO and nutrient TMDLs for subsegment 020303 with 1,000 cfs from Davis Pond Diversion.

	Loads (kg/day)				
	CBODu	**Organic N**	**Ammonia N**	**NO2+NO3 N**	**Phosphorus**
Point source wasteload allocation (WLA)	231.62	20.45	39.75	99.18	49.59
Nonpoint source load allocation (LA)	24918.22	3397.48	718.06	97.88	391.58
Explicit Margin of Safety (10%)	3143.73	427.24	94.73	24.63	55.15
Future Growth (10%)	3143.73	427.24	94.73	24.63	55.15
Total maximum daily load (TMDL)	31437.30	4272.41	947.27	246.32	551.47

Based on EPA's understanding, if any future diversion from the Mississippi River or other tributaries into Lake Cataouatche increases flow, the nonpoint source LA and the TMDL will also be increased proportionately. Based on EPA's current understanding, the diversion projects are supported by both State and Federal agencies, including EPA and the U.S. Army Corps of Engineers. The diversions are managed by the Corps of Engineers and the State, and the projects include post-diversion monitoring to determine effectiveness of the project and to monitor water quality conditions.

8.4 Seasonal Variation

As discussed in Section 7.1, critical conditions for DO in Louisiana waterbodies have been determined to be when there is negligible nonpoint runoff and low stream flow combined with high water temperatures. In addition, the model accounts for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the waterbodies during higher flows settle to the bottom and then exert the greatest oxygen demand during the high temperature seasons.

8.5 Margin of Safety

The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. As discussed in Section 7.1, the highest temperatures occur in July through August and the lowest stream flows may occur in other months. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implicit MOS which is not quantified. In addition to the implicit MOS, the TMDLs in this report set aside 20% of the allowable loading for the explicit MOS and future growth component combined.

8.6 Ammonia Toxicity Calculations

Although subsegment 020303 is not on a 303(d) List for ammonia, the ammonia concentrations predicted by the projection model were checked to make sure that they did not exceed EPA criteria for ammonia toxicity (EPA 1999). The EPA criteria are dependent on temperature and pH. The water temperature used to calculate the ammonia toxicity criterion for Lake Cataouatche was the same as the critical temperature used in the projection simulation (31.2°C). For pH, an average of the values measured at LDEQ station 0910 was used. The resulting criterion was 1.7 mg/L of ammonia nitrogen. The instream ammonia nitrogen concentrations predicted for Bayou Verret and Lake Cataouatche by the QUAL-TX model (#0.16 mg/L) were well below the criterion. This indicates that the ammonia nitrogen loadings that will maintain the DO standard are low enough that the EPA ammonia toxicity criteria will not be exceeded under critical conditions. The ammonia toxicity calculations are shown in Appendix Z.

9.0 SENSITIVITY ANALYSIS

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients, and in the hypothesized relationships among the parameters of the model. The sensitivity analyses were performed by allowing the QUAL-TX model to vary one input parameter at a time while holding all other parameters to their original value. The revised calibration simulation was used as the baseline for the sensitivity analysis. The percent change of the model's minimum DO projections to each parameter is presented in Table 9.1. Each parameter was varied by ±30%, except for temperature, which was varied ±2ºC.

Values reported in Table 9.1 are sorted by percentage variation of minimum DO from smallest percentage variation to largest. The predicted DO was most sensitive to SOD, reaeration, and depth, and it was least sensitive to headwater and lower boundary inputs.

Table 9.1. Summary of results of sensitivity analysis.

Input parameter	Predicted minimum DO (mg/L) with input parameter changed by:		Average percent change in DO
	-30%	+30%	
Baseline simulation (no change)	2.40		--
SOD	3.61	**	50.4%
Reaeration	**	3.59	49.6%
Depth	**	3.16	31.7%
Temperature	2.99	**	24.6%
Velocity	2.74	2.00	15.4%
Algae Growth	2.31	**	3.8%
Algae Respiration	2.44	2.27	3.5%
NH3 Decay	2.31	2.41	2.1%
NH3 Source	2.42	2.38	0.8%
Algae Settling	**	2.38	0.8%
Tributary PO4	2.39	2.41	0.4%
Tributary Flow	2.39	2.41	0.4%
BOD Decay	2.42	2.40	0.4%
Tributary NO3-N	2.41	2.40	0.2%
Tributary NH3-N	2.41	2.40	0.2%

Table 9.1. (Continued)

Input parameter	Predicted minimum DO (mg/L) with input parameter changed by: -30%	+30%	Average percent change in DO
Baseline simulation (no change)	2.40		--
Tributary BOD	2.41	2.40	0.2%
Lower Boundary PO4	2.40	2.41	0.2%
Headwater PO4	2.40	2.41	0.2%
Tributary Chlorophyll a	2.40	2.40	0.0%
Tributary DO	2.40	2.40	0.0%
PO4 Benthic Source	2.40	2.40	0.0%
Lower Boundary NO3-N	2.40	2.40	0.0%
Lower Boundary NH3-N	2.40	2.40	0.0%
Lower Boundary DO	2.40	2.40	0.0%
Lower Boundary Chlorophyll a	2.40	2.40	0.0%
Lower Boundary BOD	2.40	2.40	0.0%
Headwater NO3-N	2.40	2.40	0.0%
Headwater NH3-N	2.40	2.40	0.0%
Headwater Flow	2.40	2.40	0.0%
Headwater DO	2.40	2.40	0.0%
Headwater BOD	2.40	2.40	0.0%
Dispersion	2.40	2.40	0.0%

** Algal/photosynthetic rates were non-convergent in these simulations.

10.0 OTHER RELEVANT INFORMATION

This TMDL has been developed to be consistent with the antidegradation policy in the LDEQ water quality standards (LAC 33:1X.1109.A).

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the Federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (Water Quality Inventory) and the 303(d) List of impaired waters. This information is also utilized in establishing priorities for the LDEQ NPS program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a four-year cycle. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the four-year cycle. Sampling is conducted on a monthly basis to yield approximately 12 samples per site each year the site is monitored. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, approximately one half of the state's waters are newly assessed for 305(b) and 303(d) listing purposes for each biennial cycle with sampling occurring statewide each year. The four-year cycle follows an initial five-year rotation which covered all basins in the state according to the TMDL priorities. This will allow the LDEQ to determine whether there has been any improvement in water quality following implementation of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) list.

11.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999 Court Order, these TMDLs were prepared under contract to EPA. After development of these TMDLs, EPA issued a notice seeking comments, information, and data from the general and affected public. Comments were submitted by four organizations during the public comment period, and these TMDLs have been revised accordingly. Responses to these comments are included in Appendix AA, EPA has transmitted the revised TMDLs to LDEQ for implementation and incorporation into LDEQ's current water quality management plan.

12.0 REFERENCES

EPA. 1985. Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (Second Edition). Written by G.L. Bowie et. al. EPA/600/3-85/040. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

EPA. 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia. EPA-822-R-99-014. U.S. Environmental Protection Agency, Office of Water. December, 1999.

EPA. 2000. Modified Court Ordered 303(d) List for Louisiana. Downloaded from EPA Region 6 website (www.epa.gov/earth1r6/6wq/ecopro/latmdl/modifiedcourtorderedlist.xls).

FTN. 2002. Results of Intensive Survey for Subsegments 020201 and 020303 of Barataria Basin in southern Louisiana. Memorandum dated September 14, 2002.

FTN. 2003. Results of Intensive Survey for Subsegments 020201 and 020303 of Barataria Basin in southern Louisiana. Memorandum dated September 12, 2003.

LDEQ. 2003a. Environment Regulatory Code. Part IX. Water Quality Regulations. Chapter 11. Surface Water Quality Standards. § 1123. Numerical Criteria and Designated Uses. Printed from LDEQ website (www.deq.state.la.us/ planning/regs/title33/33v09.pdf).

LDEQ. 2003b. Louisiana TMDL Technical Procedures Manual. Developed by LDEQ Office of Water Resources. Revised by R.K. Duerr and M.U. Aguillard, Engineering Services Group 2, Environmental Technology Division, Louisiana Department of Environmental Quality, Baton Rouge, LA: September 22, 2003.

LDNR. 2002. Davis Pond Freshwater Diversion Project Annual Report 1998-2001. Coastal Restoration and Management Division, Louisiana Department of Natural Resources, Baton Rouge, LA: September 2002.

Lee, F.N., D. Everett, and M. Forbes. 1997. Lowflow Data for USGS Sites through 1993. Report prepared for LDEQ. March 1997.

Smythe, E. deEtte. 1999. Overview of the 1995 and 1996 Reference Streams. Prepared for Engineering 2 Section, Environmental Technology Division, Louisiana Department of Environmental Quality, Baton Rouge, LA: June 28, 1999.

US Department of Commerce. 1979. Climatic Atlas of the United States. National Climatic Data Center. Asheville, NC.

USGS. 1971. Drainage Area of Louisiana Streams. Basic Records Report No. 6. Prepared by US Geological Survey in cooperation with Louisiana Department of Transportation and Development Baton Rouge, LA: 1971 (Reprinted 1991).

USGS. 1998. Louisiana GAP Land Use/Land Cover Data. Downloaded from Spatial Data and Metadata Server, National Wetlands Research Center, US Geological Survey. (http://sdms.nwrc.gov/gap/landuse.html).

Wiland, B. L. and K. LeBlanc. 2002. LA-QUAL for Windows User's Manual, Model Version 6.02, Manual Revision H. Wiland Consulting, Inc. and Louisiana Department of Environmental Quality. June 25, 2002.

APPENDICES A-Z

Available for EPA

APPENDIX AA

Response to Public Comments